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PROGRESS REPORT ON NASA GRANT NsG 436

Experimental Research

Two kinds of closed loop servosystems for the LaCoste Romberg gravimeter have been completed and three instruments are now operating. All use electrostatic restoring forces to restore the mass to its equilibrium position. The voltage required to do this is a measure of acceleration due to gravity. One system employs a light beam and wiggly wire to sense changes of mass position. The second system employs the unbalance of a radiofrequency bridge to sense the position of the mass. The latter system is simpler and gives excellent performance. Preliminary estimates indicate that the noise performance at very low frequency (less than 3 cycles per hour) is at least two orders better than that of previous instruments. This system is believed to meet the performance requirements of the Apollo gravitational experiment, provided suitable repackaging is done to meet flight specifications.

Theoretical Research

Calculations have continued on gravimeter arrangements for the Apollo gravitation experiment, which will permit the kind of temperature control which will be required. Present indications are that an instrument mounted in a reflector which exchanges energy with the cold sky and never "sees" the sun may be satisfactory.

Research has continued on gravitational collapse and gravitational radiation.

The following publications appeared:

Rec'd earlier C.W. Misner, "Relativistic Equations for Spherical Gravitational Collapse with Escaping Neutrinos" The Physical Review 137, pp.B1360 - 1364, 8 March 1965

Rec'd earlier C.W. Misner (with R.W. Lindquist and R.A. Schwartz) "Vaidya's Radiating Schwarzschild Metric" The Physical Review 137, pp. 1364 - 1368, 8 March 1965

Rec'd earlier C.W. Misner (with D.H. Sharp) "Spherical Gravitational Collapse with Energy Transport by Radiative Diffusion" Physics Letters 15 pp. 279 - 281, 1 April 1965

The following reprint was issued:

C.W. Misner (with D.H. Sharp) "The Equations of Relativistic Spherical Hydrodynamics", a paper presented at the Second Texas Symposium on Relativistic Astrophysics, Austin, Texas, December 1964, to appear in the symposium "Proceedings", Univ. of Chicago Press

The following oral reports were presented at the annual "Relativity Conference at Steven's Institute of Technology" in Hoboken, N.J., on 26 January 1965:

C.W. Misner "The Schwarzschild Singularity as a Physical Reality"

C.V. Vishveshwara "Instability of the Exterior Schwarzschild Space-Time"

R.A. Matzner "Hildreth's Problem: The Scattering of Scalar Waves by a Schwarzschild Singularity"

W.C. Hernandez, Jr., "Spherical Gravitational Collapse in Observer-Time Coordinates"

L.M. Cheng "A Kruskal-like Extension of Vaidya's Metric for a Radiating Sphere"

R. Isaacson "The Geometrical Optics Limit for Gravitational Waves"

The work which Cheng, Hernandez, and Matzner reported on at Steven's Institute in January has in each case led to final results by now and

manuscripts are currently being prepared for publication. Isaacson's work on the geometrical optics of gravitational waves has led to some curious relations between the "pseudo-tensor" energy densities and the energy densities which are effective in producing long-range (Newtonian-like) fields, and the investigation proceeds. Vishveshwara's work on stability is nearly complete. Maitra has found a new solution of the Einstein equations which is free from singularities and can be interpreted as an inhomogeneous cosmological model. Its properties, including stability, and its interpretation are being studied further. Edelstein has found the corrected forms for the radial equations (even case) of Regge and Wheeler's problem of perturbations to the Schwarzschild metric, and is completing the tabulation of orthogonality and normalization constants needed to carry out expansions in tensor spherical harmonics. These will shortly be applied to a problem of gravitational radiation. H.S. Zapolsky has continued his analysis (in collaboration with E. Salpeter at Cornell University) of the structure of (Jupiter-like) cold masses in equilibrium. He has also embarked on a study of the stability of neutron stars which could provide the first trustworthy calculation of gravitational-radiation-reaction forces where they are not negligible.

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